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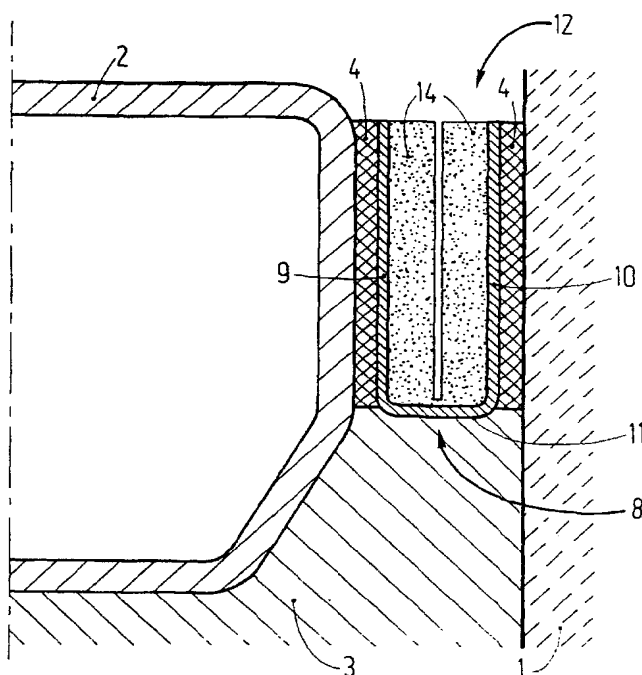
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(54) Title: AN INSULATING GLASS UNIT WITH SPACER WITH GAS TIGHT LIP SEAL



(57) Abstract: A sealed insulating glass unit comprising two glass panes (1) spaced apart by at least one spacer element (2) is provided with a lip sealing system including a gas impervious film strip (8), e.g. of metal or a laminate. The film strip (8) is connected to glass panes (1) and to the spacer element (2), respectively, by butyl-containing adhesive sealant (4). The invention also comprises a separate spacer element with lip seal or flexible gas sealing for an insulating glass unit. The strip (8) allows mutual angular and linear displacements of glass panes (1) and spacer element (2), thereby relieving the adhesive sealant (4) from mechanical loads to a great extent, consequently avoiding cracks in the sealant (4) without compromising sealing against moisture/gas exchange between the interior of the glass unit and the ambient atmosphere. Also, the sealing system provides possibility of increasing the gap (12) between pane (1) and spacer (2), possibly filling with a thermal insulating material (14) and thus improving the otherwise inferior thermal insulation of the edge of the glass unit.

## AN INSULATING GLASS UNIT WITH SPACER WITH GAS TIGHT LIP SEAL

**State of the Art**

5 The invention concerns a sealed insulating glass unit comprising at least two glass panes that are spaced apart by at least one spacer element, where the space delimited by the spacer element and the panes is sealed off for preventing gas exchange with ambient atmosphere by means of a sealing system including an adhesive sealant disposed between the spacer elements and the panes. The invention also concerns a spacer element with a sealing system for sealing off a space delimited by glass panes and the spacer element in a sealed insulated glass unit.

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Such insulating glass units are very common type in buildings containing housing or offices, and the number of panes in the unit is usually two or three though a greater number is possible. The spacer elements are usually rolled or extruded, and hollow sections are preferred for containing the moisture absorbing material, although completely solid or composite configurations, e.g. foam with metal reinforcement, are known. Most of existing manufacturing equipment for making insulating glass units is designed for closed metal spacer elements, and customers are used to this design which is visible in the mounted state of the units. For access to the moisture absorbing material inside the spacer elements, these are often provided with perforations on the side facing the space between the last panes. The adhesive sealant connecting the spacer elements with the glass panes is usually a butyl-containing mass which has large resistance to diffusion of different gases and water. This adhesive sealant has superior sealing qualities but inferior bonding qualities compared with the outer and more sturdy sealing mass covering the side of the spacer element facing away from the space between the glass panes and which fills out the joint between the glass panes, i.e. the edge of the glass unit. Also the ability of the adhesive sealant to accommodate to displacements between spacer element and pane is small due to the narrow dimension of the sealant. Since most spacer elements by themselves present a virtual barrier to diffusion of gas or moisture, the weak point in the sealing is the adhesive sealant in that cracks often appear in the sealant due to thermal displacements, be they angular or linear, between the spacer element and the panes.

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Another problem in the state of the art is the heat transmission coefficient in the edge region of the glass unit. When the spacer element is made of metal, the specific insulation value along the edge is rather low. The adhesive sealant has better insulation ability than the spacer element but increasing the thickness of the sealant also increases the area through which gas may be exchanged through the sealant and the strength of the sealant to tensile forces is also reduced, thereby increasing the possibility of cracks. If the spacer element is made of synthetic material, the thermal insulation value is increased but due to the diffusion properties of the material, a film or other member of gas impervious material, e.g. of metal, has to be embedded in the synthetic spacer element.

One solution to the above problems is shown in EP 613 990 B2 where a U-shaped spacer element of polymeric material is provided with a thin film of gas impervious material. The legs of the U are sealed to the glass panes in a conventional way. This design may accommodate to angular displacements of the panes as the legs of the spacer element are resilient. However, due to the transverse base member of the U, the ability to accommodate to linear displacements perpendicularly to the plane of the glass panes is very limited, thus maintaining the risk of crack formation in the sealant. Also, this design cannot be applied with existing production equipment. Furthermore, this open design of the spacer element carrying visible moisture absorbing material is visible from outside, an undesirable feature for marketing reasons.

US patent no. 5,290,611 shows a composite material spacer element of hollow design, but with overlapping, free ends. The sides of the spacer element are bonded with sealant to the glass panes. This design has the same drawbacks as that of the EP patent with regard to linear displacements and production equipment.

WO 99/15753 describes a closed, hollow spacer element of polymeric material covered with or containing a film of gas impervious material. The element has lateral flanges connected to the body of the element by bridge members and extending more or less in parallel with the body. The outward facing sides of the flanges are bonded to

the glass panes, thereby giving greater angular flexibility to the design. However, this design has the same drawbacks as those of the above EP and US patents.

### Summary of the Invention

5 The peculiar feature of the insulating glass unit according to the invention is that the sealing system includes a pliable element constituted by a strip of film of gas/moisture diffusion impervious material, the film strip comprising a first film section fastened to the spacer element, at least one second film section co-extending with the spacer ele-  
10 ment and fastened to an adjacent glass pane by the adhesive sealant, and further comprising a continuous third section of the film strip between the first and second sections and bridging a substantial part of a gap between the spacer element and the adjacent glass pane.

The pliable film strip is preferred to be of stainless steel or other metal acting as bar-  
15 rier to gas or moisture diffusion but other materials, e.g. polymers or laminates, are feasible. By “pliable” is meant yielding or flexible transversely of the film though not necessarily yielding in the plane of the film. The spacer element may be of metal for using existing production equipment and for fulfilling customer expectations concern-  
20 ing the visible design but spacer elements of polymeric or composite material are also possible. While the first section and the second sections of the film strip are fastened to spacer element and glass pane, respectively, the third section forms a diffusion barrier in the intermediate space, making possible a greater gap between pane and  
25 spacer element for both, angular and linear (translational), even simultaneous, displacements without loading the adhesive sealant, thereby counteracting or even excluding crack formation in the sealant due to mechanical load. Also the layer of adhe-  
30 sive sealant may be reduced to a minimum thickness, thereby reducing the diffusion area of the sealant through which gas and vapour may be exchanged between the enclosure in the unit and the ambient atmosphere. Since the mechanical load on the adhesive sealant is alleviated due to the flexible strip, the height of the sealant from the edge of the glass unit toward the interspace between the panes may be increased, consequently increasing the length of the way of travel of moisture along the interface between pane and sealant. Finally, the thermal insulation at the edge between spacer

element and panes may be increased as the film can be made very thin and as the gap between pane and spacer element may be more or less filled with gas or material with relatively large thermal insulation ability.

5 The spacer element according to the invention is peculiar in that the sealing system includes a pliable element constituted by a strip of film of gas/moisture diffusion impervious material, the film strip comprising a first film section fastened to the spacer element, at least one second film section co-extending with the spacer element, the second film section being dimensioned and arranged to be fastened to a glass pane by  
10 adhesive sealant, and further comprising a continuous third section of the film strip between the first and second sections connecting the second and third sections.

The inventive spacer element with one or more film strips fastened thereto may thus be produced and supplied as a separate unit for later assembly with glass panes into a  
15 sealed insulating unit. Adhesive sealant may be applied to the second section of the film strip during making of the spacer element for ready joining to glass panes later on. Alternatively, the second section of the film strip or strips of the sealing system of the spacer element may be without adhesive sealant which is only applied during the assembling of the glass unit.

20 According to one embodiment of the invention, an opposite side of the second section of the film strip is supported by a resilient and/or plastically deformable mass disposed between the spacer element and the second section of the film strip. When applying the film strip in connection with existing production equipment, it is necessary to support the free section of the strip while assembling the glass unit, and the deformable  
25 mass may serve as auxiliary support for the free section during this process. A wide range of different materials may be suitable for different embodiments of the invention, including purely plastic materials and purely elastic materials as well as materials with a mixture of these properties. Also, the deformable mass may be tacky or non-  
30 tacky according to which adhesive properties are desirable in the actual situation.

In a further embodiment comprising the deformable mass, the dimension of the mass measured as the distance between the spacer element and the second section of the film strip is greater than the dimension of the adhesive sealant measured as the distance between the second section of film strip and an adjacent glass pane. With this design and even if the deformable mass has the same mechanical properties as the adhesive sealant, the mass will absorb more of the deformation imparted by the relative movements of panes and spacer element, respectively. Another way of providing greater deformability is to let the mass between the spacer element and the film strip have more yielding ability than the adhesive sealant between the film strip and one of the glass panes.

When using a further embodiment of the invention comprising existing spacer elements, it is advantageous to fasten the first section of the film strip by bonding to at least one outer surface of the spacer element, thereby avoiding any geometrical change of the spacer element section. In a still further embodiment of the invention, the third section of the film strip may be arranged with a folding between the first and second section, and that a resilient and/or plastic deformable mass is disposed between mutually facing sides of the first and second sections of the film strip. In this case use is made of a deformable mass as described in previous embodiment, e.g. with the film strip section formed as an inverted U with the mass between the legs.

In a further embodiment, the first section of the film strip is fastened to the spacer element in a longitudinally extending slit in the spacer element. The slit may be formed by a cutting operation, by moulding, extrusion, roll forming, or other shaping processes, and the film strip section may be fastened in connection with the shaping process. Alternatively, bonding may be used for securing the strip in the slit. In any case, diffusion along the interface between spacer element and first section of the film strip is reduced to a minimum.

Another embodiment of the invention features the film strip extending across the interspace between the glass panes as a continuous web having two lateral second sections, one at each side of a central first section with intermediate third sections of the

film strip, where each second section is connected to a pane by bonding with the adhesive sealant. The first section may e.g. be bonded to spacer element surface facing the inner of the glass unit, thereby creating an unbroken diffusion barrier from pane to pane except for the narrow section of adhesive sealant along the panes. This embodiment may be modified in that the spacer element is composed of at least two longitudinal, mutually engaging parts, and that the film strip is fixed between the parts of the spacer element by clamping or snap action of the parts.

If the spacer elements are moulded in a synthetic material, possibly with a metal diffusion barrier embedded, it may be advantageous that the first section of the film strip is fastened to the spacer element by embedding in the spacer element too.

Advantageous embodiments of the spacer element with sealing system are indicated in claims 12 - 18.

### **The Drawing**

Embodiments of the invention will now be explained in more detail with reference to the drawing, wherein:

- Fig. 1 shows a section through a lower edge of a prior art glass unit with conventional sealing system,
- Fig. 2 shows a partial section of a first embodiment of a sealing system of a glass unit according to the invention,
- Fig. 3 shows a partial section of a second embodiment a sealing system of a glass unit according to the invention,
- Fig. 4 shows a partial section of a third embodiment of a sealing system of a glass unit according to the invention with modified spacer element,
- Fig. 5 shows a section through an upper edge of a fourth embodiment of a glass unit according to the invention with two-part spacer element acting as housing for a blind winding mechanism,
- Fig. 6 shows a partial section of a fifth embodiment of a sealing system in a glass unit according to the invention,

- Fig. 7 shows a partial section of a sixth embodiment of a sealing system of a glass unit according to the invention with two part spacer element,
- Fig. 8 shows a section through an edge of a seventh embodiment of a sealing system in a glass unit according to the invention, and
- 5 Fig. 9 shows a partial section of an eighth embodiment of a sealing system in a glass unit according to the invention.

### Description of Embodiments of the Invention

The common prior art configuration of a sealed insulated glass unit is shown in Fig. 1, where 1 designates the glass panes, 2 the spacer element, 3 the bonding, yet yielding, material holding the glass panes and the spacer element 2 in relative position but having rather inferior diffusion barrier properties, and 4 the adhesive sealant, usually a butyl compound, with good diffusion barrier properties for preventing diffusion of gas and/or moisture into the space 5 inside the glass unit or exchange of gas with the ambient atmosphere. Thermal changes in the glass unit during use causes moments of force occurring in the sealing system of the insulating glass unit as indicated with M as well as linear or translational forces acting in direction indicated with L. These actions deform the elastic bonding material 3 and stresses the adhesive sealant 4 with the risk of crack formation in the sealant or in the interfaces 6 between sealant 4 and pane 1 or spacer 2, respectively. Since the cross dimension of the sealant has to be small in order to reduce the diffusion area between the space 5 and the ambient atmosphere, the accommodating ability of the sealant 4 is rather limited.

In a first embodiment as shown in Fig. 2, there is used a conventional spacer element 2, usual of rolled or extruded aluminium or stainless steel, and where a film strip 8 is disposed at each side of the spacer element 2; this embodiment is thus advantageous where existing spacer elements, production equipment and glass unit dimensions are to be used. The strip 8 is made of material that is impervious to moisture or gas diffusion, e.g. of aluminium or polyvinylidene or of a metal/plastic laminate, and is here folded longitudinally so as to form three sections: a first section 9 fastened to the side of the spacer element 2 with adhesive sealant 4, a second section 10 fastened to the adjacent glass pane 1 with adhesive sealant 4, and a third section 11 bridging the two

other sections 9,10. With this version of the invention, formation of cracks in sealant 4 due to angular as well as linear movements of the panes 1 is prevented, since the bonding material 3 holding panes 1 and spacer element 2 together is just yielding to the movements. The ability to absorb linear displacements between spacer element 2 and pane 1 may be enhanced if the third section 11 is made larger than shown on Fig. 2, e.g. as a bulging fold or pleated as bellows.

In the second, preferred embodiment shown on Fig. 3, which is basically the configuration of Fig. 2, a conventional spacer element 2 may be used but providing a larger gap 12 between spacer element 2 and glass pane 1 for achieving better insulation along the edge of the glass unit since this is the thermal bridge of the glass unit due to the mechanical connection of the edge of the unit which often includes metal spacer elements. Hereby is also provided a broader third section 11 of the film strip 8. The interspace between the first and second section 9,10 is filled with filling material 14, e.g. as one piece or, as shown, in two pieces 14, acting as support for the second film strip section 10 during assembly of the glass unit, where the spacer frame with elements 2 and strips 8 with sealant 4 are joined with the panes 1. The material 14 also absorbs irregularities and inaccuracies in the constituent parts and in production equipment during production of the glass units. Thereby existing production equipment may be used. The filling material 14 may be e.g. a foam polymer, an elastomer, a kind of wax, or any other kind of material having suitable resilient or just yielding properties, which may adhere to the film strip 8 by itself or by means of glue, and which have suitable thermal insulation properties.

Fig. 4 is showing a further embodiment of the invention with a modified spacer element 16 which may be extruded in metal or plastic. The side of the spacer element 16 is provided with a groove 17 for receiving the first section 9 of the film strip 8 with adhesive sealant 4 and filling material 14. Thus the gap 12 may be wide for insulation purposes in the region of the film strip 8 while at the same time the groove 17 facilitates mounting the film strip 8 on the side of the spacer element 16.

In a special embodiment of the invention, see Fig. 5, comprising a built-in blind winding mechanism 18 between the glass panes, a spacer element 19 may be designed consisting of two parts 20,21, where one part 20 is provided with a film strip connection 22 between the spacer element 19 and the panes 1. The film strip may be configured as in any of Figs. 2 - 4.

A further embodiment of the invention as shown in Fig. 6 comprises a conventional spacer element 2 and a single film strip 24 extending between and fastened to both glass panes 1. The strip 24 is thus provided with one central, first section 9 with two lateral second sections 10 connected with respective glass panes 1 with adhesive sealant 4. Two third sections 11, one at each side of the first section 9, connect the sections 9 and 10 and bridge most of the gap between spacer element 2 and glass pane 1. The space between second section 10 of the film strip 24 and the spacer element 2 may be provided with filler material 14 as in the above described embodiments or may just be an air gap. The first section 9 is fastened by bonding with glue to the side 25 of the spacer element 2 facing the inner space 5 of the glass unit. Except for possible holes through the side 25 and section 9 for providing access to moisture absorbing material inside the hollow spacer element 2, the film strip 24 covers the spacer element 2 completely, thereby reducing the number of adhesive sealant elements 4 from four to two with similar consequences for the diffusion area through the sealant 4 and for the number of interfaces between sealant 4 on one hand and spacer element or film strip on the other, the interfaces constituting another path for gas or moisture diffusion.

In Fig. 7 there is provided a two-part spacer element 27 with an inner part 28 facing the inner space 5 and an outer part 29 facing the bonding material 3, the parts 28,29 engaging through a longitudinal snap connection 30. The film strip 24 form a continuous web between the panes 1 as in the embodiment of Fig. 6. The first and central section 9 of the film strip is clamped in the snap connection 30 between the parts 28,29, while the other sections 10,11 are arranged similarly to the embodiment of Fig. 6. The spacer element 27 is preferred to be made of composite material, of plastic or aluminium, or of combinations of different materials in different spacer parts 28,29 for

easy snap action without damaging the film strip 8. In Fig. 7, absence of filling material between section 10 and spacer 27 is shown, however, filling material may as well be used here as in the other embodiments.

5 Fig. 8 shows a further embodiment of the invention where a spacer element 32, e.g. of metal, has a film strip 8 at each side, where first sections 9 of the strips are fastened in slits 33 at each side of the spacer element 32. The fastening may be imparted by bonding with glue or sealant or by squeezing the sides of the slit 33 around the film strip section 9, the latter either being done after mounting the film strips 8 in the slits  
10 33 or as an integral part of roll-forming the spacer element 32.

A composite spacer element 35, e.g. of plastic, with internal diffusion barrier 36 is shown in the embodiment of Fig. 9. Here first section 9 of film strip 8 may be embedded by co-extrusion or moulding in the side of the spacer element 35 or fastened in a  
15 slit 37 in a way similar to that of Fig. 8. The good thermal insulation properties of the composite spacer element are hereby combined with mechanical accommodating ability of the flexible or pliable film strip 8.

The adhesive sealant 4 on the second section 10 may be provided simultaneously with  
20 producing the spacer element 2,16,19,27,32,35 including film strip(s), the exposed sealant being covered, e.g. with a non-tacky paper strip, during storage and transport, or the spacer element 2,16,19,27,32,35 including film strip may be supplied to the glass unit manufacturer without sealant 4 on the second section 10 of the film strip, in the latter case sealant being applied during assembling the sealed insulating glass unit.

25 Intermediate filling material 14 may also, according to what is suitable, be provided during the making of the spacer element 2,16,19,27,32,35 before delivery as a sub-unit or fitted later during the assembling of the glass unit.

30 The depicted embodiments all show hollow spacer elements but solid or porous spacer elements of suitable material may of course be applied to the inventive glass unit and spacer element.

Various combinations of features of different embodiments described above are possible within the scope of the claims.

## CLAIMS

1. A sealed insulating glass unit comprising at least two glass panes that are spaced apart by at least one spacer element, where a space delimited by the spacer element and the panes is sealed off for preventing gas exchange with ambient atmosphere by means of a sealing system including an adhesive sealant disposed between the spacer elements and the panes, **characterised** in that the sealing system includes a pliable element constituted by a strip of film of gas/moisture diffusion impervious material, the film strip comprising a first film section fastened to the spacer element, at least one second film section co-extending with the spacer element and fastened to an adjacent glass pane by the adhesive sealant, and further comprising a continuous third section of the film strip between the first and second sections and bridging a substantial part of a gap between the spacer element and the adjacent glass pane.
2. Glass unit according to claim 1, characterised in that an opposite side of the second section of the film strip is supported by a resilient and/or plastically deformable mass disposed between the spacer element and the second section of the film strip.
3. Glass unit according to claim 2, characterised in that the dimension of the mass measured as the distance between the spacer element and the second section of the film strip is greater than the dimension of the adhesive sealant measured as the distance between the second section of film strip and an adjacent glass pane.
4. Glass unit according to claim 2 or 3, characterised in that the mass between the spacer element and the film strip has more yielding ability than the adhesive sealant between the film strip and one of the glass panes.
5. Glass unit according any preceding claim, characterised in that the first section of the film strip is fastened by bonding to at least one outer surface of the spacer element.
6. Glass unit according to claim 5, characterised in that the third section of the film strip is arranged with a folding between the first and second section, and that a resil-

ient and/or plastic deformable mass is disposed between mutually facing sides of the first and second sections of the film strip.

5 7. Glass unit according to any of claims 1 - 4, characterised in that the first section of the film strip is fastened to the spacer element in a longitudinally extending slit in the spacer element.

10 8. Glass unit according to any of claims 1 - 4, characterised in that the film strip extends across the interspace between the glass panes as a continuous web having two lateral second sections, one at each side of a central first section with intermediate third sections of the film strip, each second section connected to a pane by bonding with the adhesive sealant.

15 9. Glass unit according to claim 8, characterised in that the spacer element is composed of at least two longitudinal, mutually engaging parts, and that the film strip is fixed between the parts of the spacer element by clamping or snap action of the parts.

20 10. Glass unit according to any of claims 1 - 4, characterised in that the first section of the film strip is fastened to the spacer element by embedding in the spacer element.

25 11. A spacer element with a sealing system for sealing off a space delimited by glass panes and the spacer element in a sealed insulated glass unit, **characterised** in that the sealing system includes a pliable element constituted by a strip of film of gas/moisture diffusion impervious material, the film strip comprising a first film section fastened to the spacer element, at least one second film section co-extending with the spacer element, the second film section being dimensioned and arranged to be fastened to a glass pane by adhesive sealant, and further comprising a continuous third section of the film strip between the first and second sections connecting the second and third sections.

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12. A spacer element according to claim 11, characterised in that an opposite side of the second section of the film strip is supported by a resilient and/or plastically de-

formable mass disposed between the spacer element and the second section of the film strip.

5 13. A spacer element according to claim 11 or 12, characterised in that the first section of the film strip is fastened by bonding to at least one outer surface of the spacer element.

10 14. A spacer element according to claim 13, characterised in that the third section of the film strip is arranged with a folding between the first and second section, and that a resilient and/or plastic deformable mass is disposed between mutually facing sides of the first and second sections of the film strip.

15 15. A spacer element according to claim 11 or 12, characterised in that the first section of the film strip is fastened to the spacer element in a longitudinally extending slit in the spacer element.

20 16. A spacer element according to claim 11 or 12, characterised in that the film strip extends transversely of the spacer element as a continuous web having two lateral second sections, one at each side of a central first section with intermediate third sections of the film strip.

25 17. A spacer element according to claim 16, characterised in that the spacer element is composed of at least two longitudinal, mutually engaging parts, and that the film strip is fixed between the parts of the spacer element by clamping or snap action of the parts.

18. Glass unit according to claim 11 or 12, characterised in that the first section of the film strip is fastened to the spacer element by embedding in the spacer element.

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Fig.1

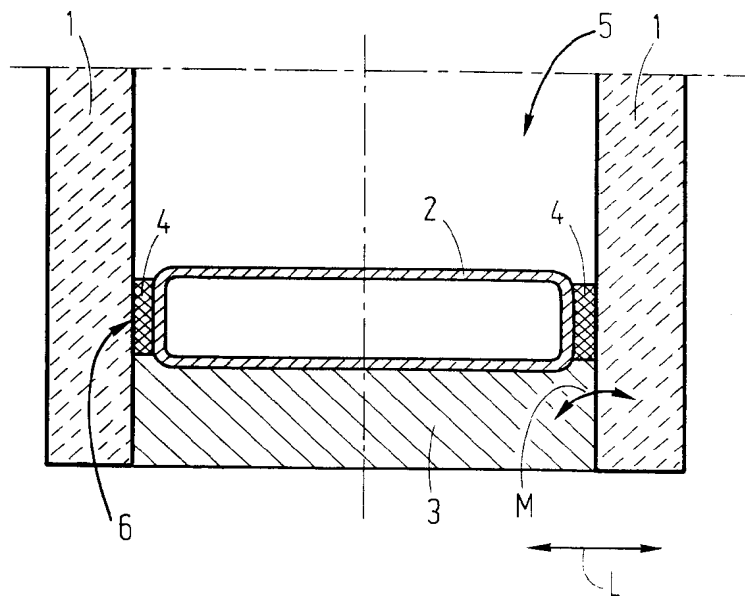
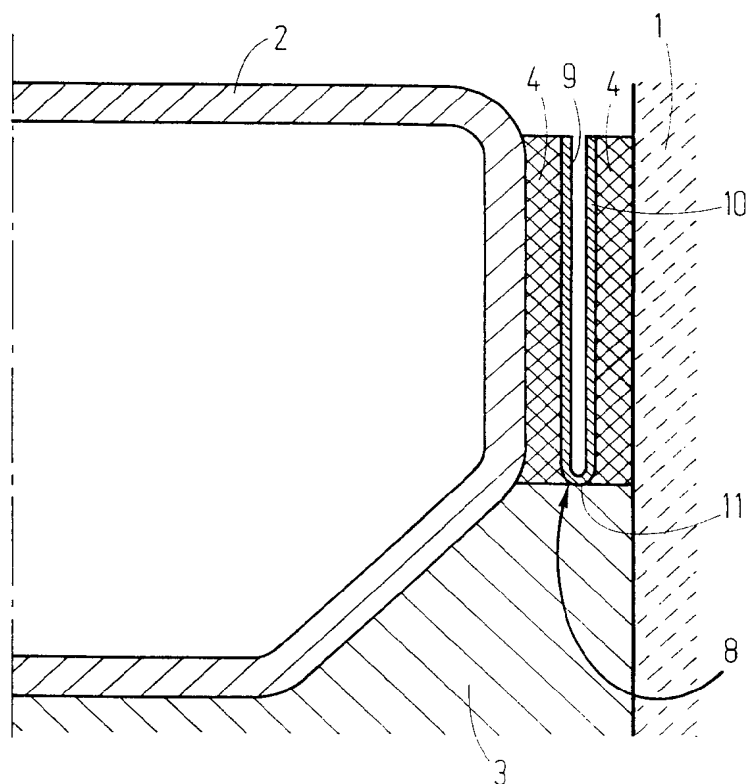


Fig.2



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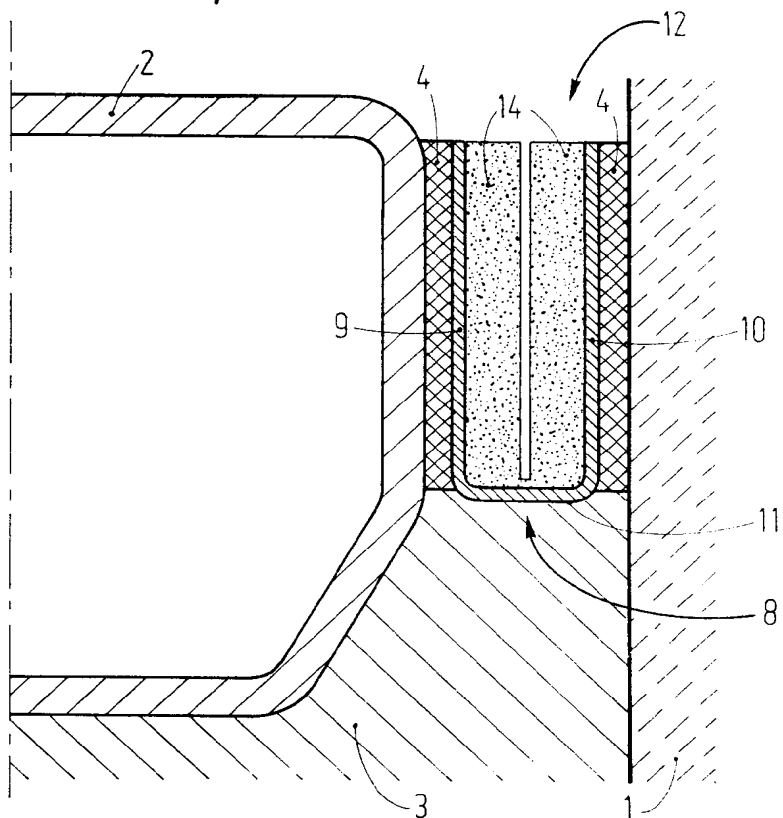


Fig. 3

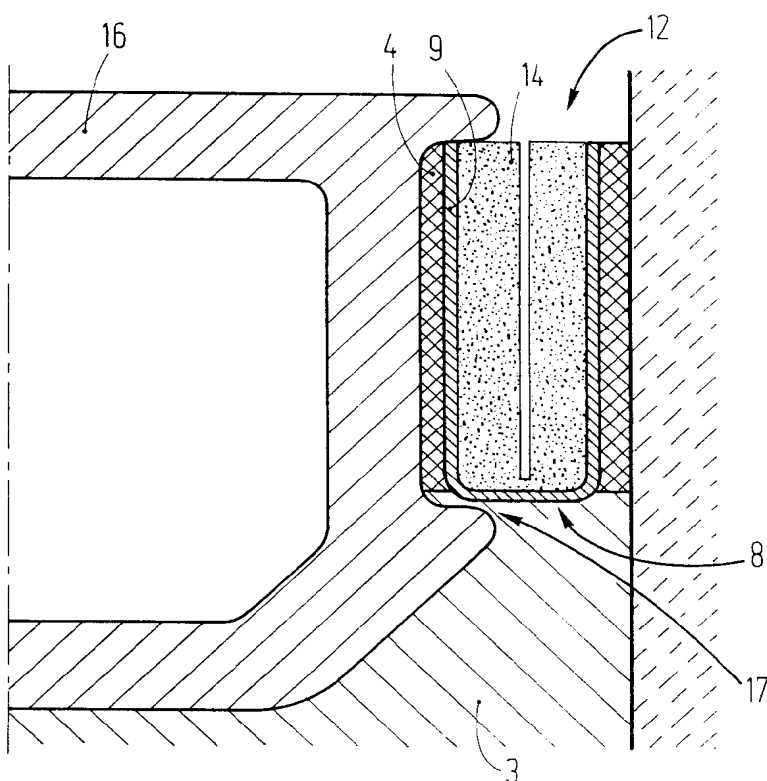


Fig. 4

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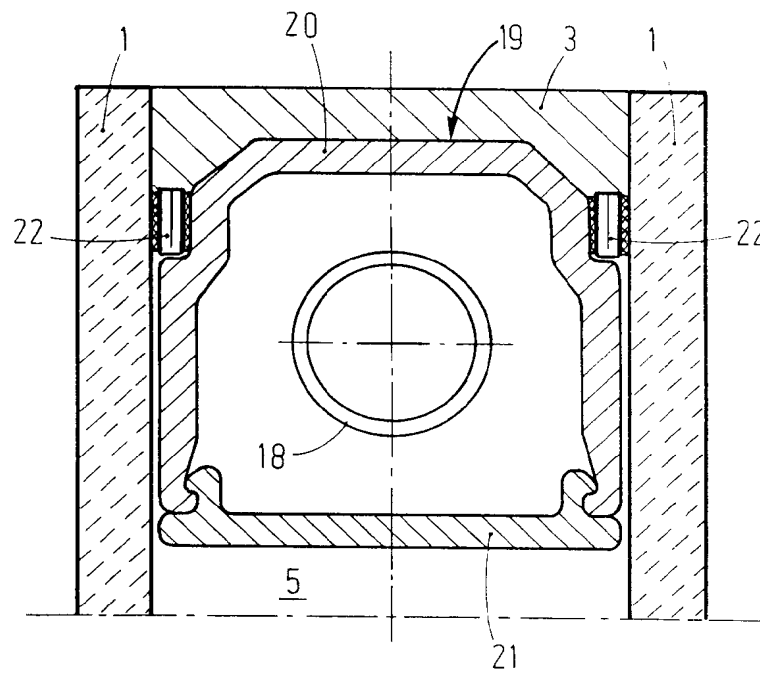


Fig.5

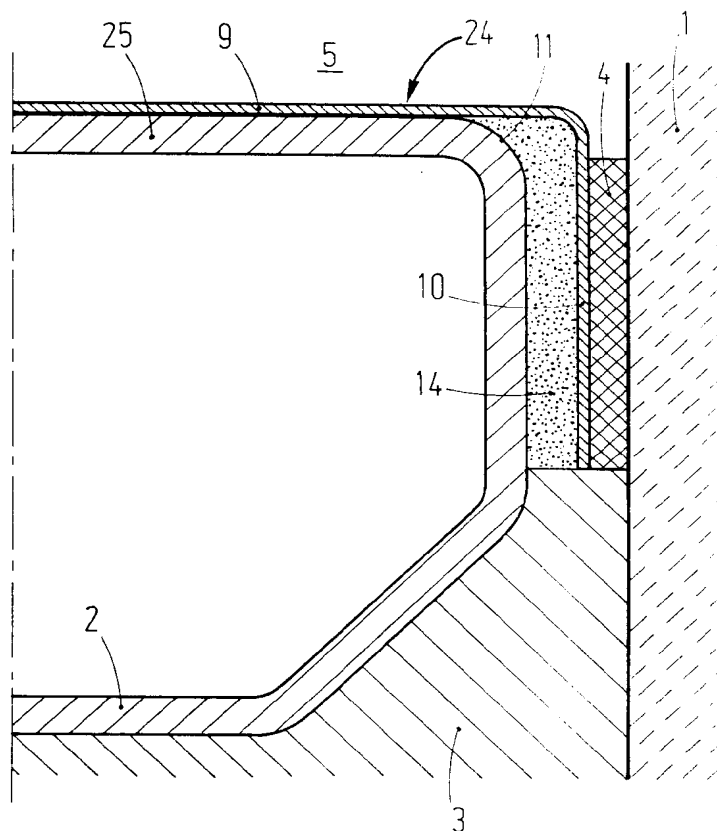
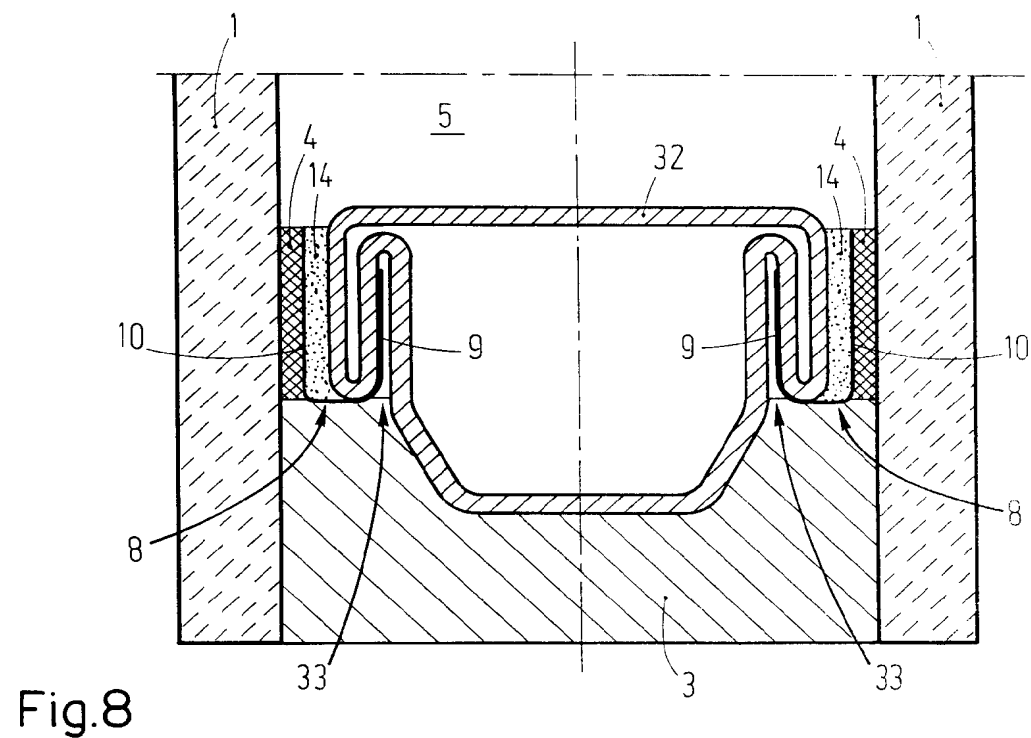
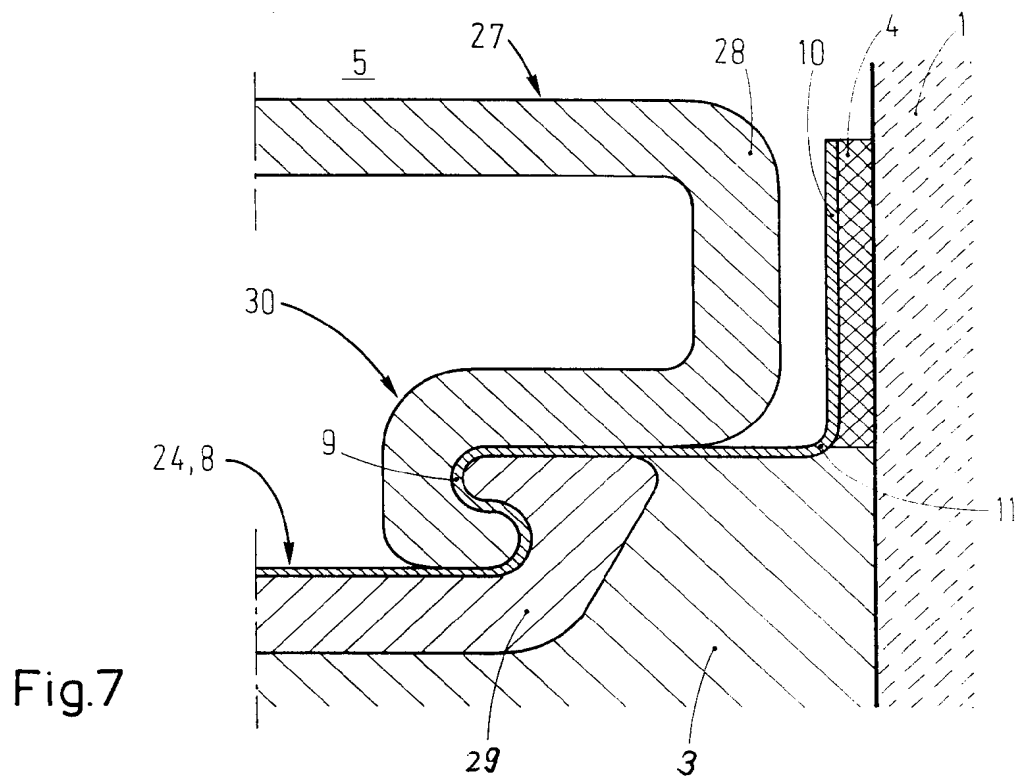


Fig.6

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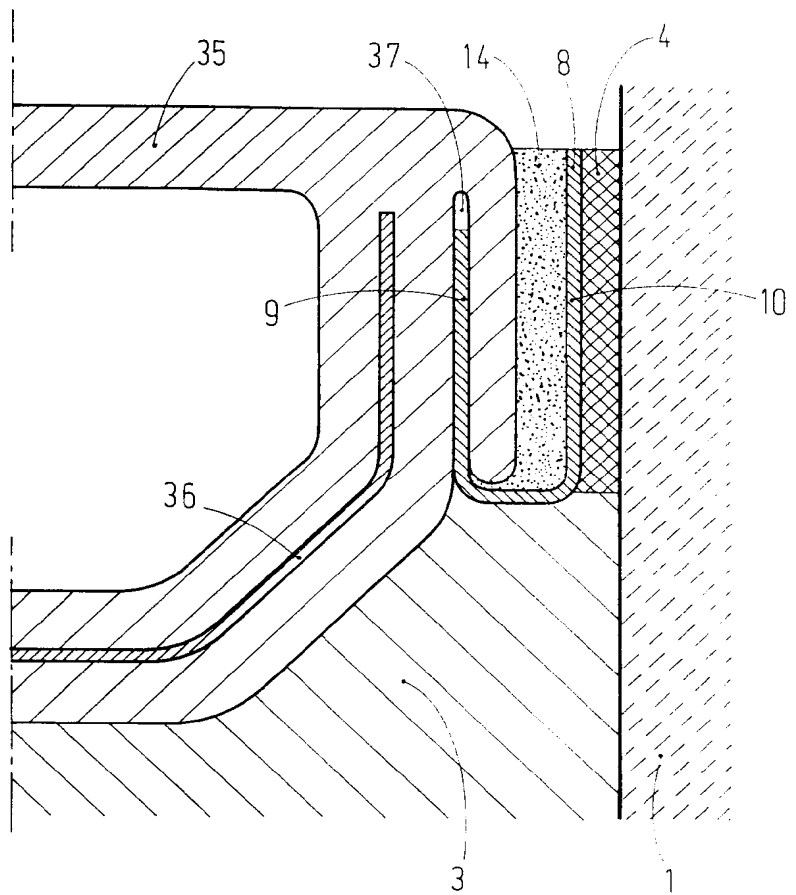


Fig.9

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 00/00572

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E06B 3/66, E06B 3/663

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E06B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0613990 A1 (PPG INDUSTRIES, INC.), 7 Sept 1994 (07.09.94), figure 10, abstract --	1,11,18
Y	EP 0403058 A1 (CARDINAL IG COMPANY), 19 December 1990 (19.12.90), column 4, line 45 - line 52, figure 2 --	1,11,18
A	US 4994309 A (REICHERT ET AL), 19 February 1991 (19.02.91), column 15, line 27 - line 37, figure 7 --	1-18
A	US 5079054 A (DAVIES), 7 January 1992 (07.01.92), column 3, line 14 - line 21, figure 2 --	1-18

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

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International application No.

PCT/DK 00/00572

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